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ABSTRACT

Research on learning-to-learn and some proposals made concerning its teaching are reviewed. Focus is on what needs to be achieved to show that learning-to-learn has occurred. Actual achievement is part of the answer, but the measurement of learning ability must occur independently of the assessment of prior knowledge. Intellectual capacities and situational and motivational factors have a bearing on learning-to-learn, but most research has focused on learning strategies. Differing methods proposed for the teaching of learning strategies are reviewed. Special curricula for learning-to-learn cannot generally be recommended, but may be useful for certain learners. It is usually considered necessary to instruct students to regulate and control their own learning processes in order to reach autodidactic learning. Only recently has the question of learning-to-learn begun to receive research attention. A 10-page list of references and two flowcharts are presented. (SLD)

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Teaching for Learning-to-Learn:

A Critical Appraisal with Some Proposals

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The Teaching for Learning-to-Learn:
A Critical Appraisal with Some Proposals

During World War I Hugo Gaudig, a renowned German educationalist, formulated a famous statement when strongly advocating the teaching of the techniques of learning and mental work to students. He wrote: "As paradoxical as it may sound, it is the student who has to have method. The teacher, however, needs to know the method of leading the student to method" (1917, p.90). His early program of learning-to-learn was characterized by refusing all attempts at teaching general techniques or strategies of learning but by arguing for the teaching of, as we would put it, domain-specific learning strategies. According to him the student should be taught how to deal with a certain type of text, how to organize a composition, how to solve algebraic word problems, and so on.

For a long time, empirical research did not support such a view. Three important streams of research have been pertinent to our problem of learning-to-learn.

a) Psychometric research was able to substantiate the notion of a general intellectual capacity, i.e. Spearman's factor g, but encountered more or less insurmountable difficulties when trying to establish a similarly general factor of learning capacity. Woodrow (1946) showed that learning measures derived from different tasks do not intercorrelate sufficiently highly to give rise to a learning factor, a result suggesting that attempts at generally improving learning ability are in vain because such an ability does not exist at all. Though later research showed a more differentiated picture by establishing group factors of learning (Allison, 1960, Stake, 1961, Games, 1962, Duncanson, 1964), these newer results could not change the generally pessimistic view of learning-to-learn. More recent attempts at measuring task-specific learning ability (Budoff, 1967), even if based upon Vygotzki's idea of the zone of proximate learning (Guthke, 1972, Guthke & Lewald, 1984), did not turn out to be so successful as to be able to brighten the picture.

b) Classical behavioristic learning psychology was successful in driving back any idea of mental discipline. Thorndike's conception of specificity of learning drastically reduced the scope of transfer of training. Taken this way, learning-to-learn could be conceived only in a very restricted task-specific way (Postman, 1969). "Learning-to-learn means improved performance on subsequent tasks as a function of prior practice on a variety of tasks" (Ripple & Dinkwater, 1982).

c) Modern cognitive psychology seems to vacillate between more optimistic and more pessimistic views. Though many important researchers stress the irreplaceable function of specific knowledge for learning and problem-solving (Elshout, 1987, Gagné, 1980, Greeno, 1980, Neber, 1978, Newell, 1980, Siegler, 1985) and additionally refer to the disappointing results of research in transfer of training, at least some of them are, nevertheless, aware of the encouraging prospects of recent training approaches (Resnick, 1987, Sternberg, 1983, Dettermann & Sternberg, 1982, Chipman, Segal, & Glaser, 1985, Segal, Chipman, & Glaser, 1985, Schwebel & Maher, 1986). The main purpose of this article is to assist in clarifying the controversial picture of today's cognitive psychology as far as learning-to-learn is concerned by evaluating its diverse approaches with respect to their relative worth and by uncovering their more or less hidden constraints.

A first step may be to envision as precisely as possible the problem at hand. What is the criterion variable showing that learning-to-learn has occurred given that it has taken place? Precisely what should be improved if one has learned to learn?

The Issue of the Criterion Variable

As far as the appropriate dependent variable is concerned several candidates are to be taken into consideration. It seems necessary first to evaluate them one after the other in order to get to a final conclusion.

Actual achievement. An improved learning capability should, all things being equal, lead to improved learning and hence to improved achievement. Conversely, high-achieving students should outperform low-achieving students in their learning abilities so that, in a way, high-achieving students could be considered to be experts in learning relative to low-achievers. On the other hand, Bransford, Arbitman-Smith, Stein, & Vye (1985) insist upon the fact that achievement cannot be equated with learning. Actually, achievement is influenced by a great number of variables so that it is far from being a good measure of learning ability.

Learning of a certain subject matter. Learning ability might best be assessed by the effectiveness of a learning activity. Therefore, it seems to be straightforward to have the students learn under standardized conditions for a certain instructional objective and to use their improvements as estimates of their learning abilities. There are, however, serious objections to such a procedure. According to Gagné (1977, cf. Gagné & Paradise, 1961) the best predictors of learning a certain subject matter are the immediate prerequisite abilities. Modern experimental analyses of learning and problem solving strongly support this position by showing the crucial impact of domain-specific knowledge on learning and problem solving (Chi, Feltovich, & Glaser, 1981, Glaser, 1987, Lauth, 1987, McKeachie, 1987, Neber, 1987, Putz-Osterloh & Lemmer, 1987, Siegler, 1983). Actual learning is more influenced by the prerequisite domain-specific knowledge than by an abstract learning ability.

Learning of any subject matter. Can the problematical impact of prerequisite knowledge be overcome by using a sampling approach when looking for appropriate learning goals? In the long run, the differential influences of prerequisite abilities should be balanced out, if only a random sampling takes place to choose the next to-be-learned subject matter. There is, however, a serious drawback to such a random sampling approach. Besides the fact that it would need a number of learning events, rather often objectives would be chosen lying far outside the range of learning objectives accessible to the student. But if the student's learning ability is to be assessed, the learning task has to open to

him a fair chance of successful learning. Learning ability clearly cannot be measured if no learning at all occurs because of lack of the prerequisite knowledge.

Learning of any subject matter in the range of immediately possible learning. The subject matter to be chosen must lie within the range of learning objectives the learner normally is able to learn. Learning ability or its improvement can be assessed using a learning task if all of the learners have the same level of immediate prerequisite knowledge. If, for example, the students are equipped with the same domain-specific knowledge that is a sufficient prerequisite to the learning objective, then differences in unaided learning can be traced back to differences in learning ability. In this case, we can use learning of such an objective as the dependent variable, of an objective of which the learners are provided with the necessary prerequisites. The range of immediately possible learning may be defined as the total of subject matters the learner is provided with the necessary prerequisites of learning so that he or she is able to learn them without any intervening learning process. Thus, the dependent variable looked for can be designated as autodidactic learning of any subject matter in the range of immediately possible learning. Assessing learning ability this way implies a short term experimental design or an appropriate statistical procedure like residualized gain scores, i.e. gain scores with prior knowledge differences partiated out.

Learning of a more complex subject matter. It is obviously an educationally much more promising goal to enable the students to learn independently a complex domain of subject matter that needs a study time of several weeks or even months. Valuable as such a criterion would be, every medium or long term learning process cannot be treated experimentally because of the multitude of uncontrolled intervening variables. This criterion entails quasi-experimentation (Cook & Campbell, 1979) which should be avoided if possible. There are only these technical reasons why the criterion if learning a bigger complex of subject matter cannot be recommended in the first place.

Studying and working behavior. Quite a different kind of variables to measure improvement in learning-to-learn is actual kinds of studying behavior. It is certainly worthwhile to see whether or not an effort of teaching for learning-to-learn has an impact on the students' actual studying behaviors. The best way to this end would be to continually observe students when learning. Such a procedure is, however, burdened with a great number of technical problems. That is the reason why researchers often prefer pertinent questionnaires (Zimmerman & Martinez Pons, 1986, Weinstein & Underwood, 1985, Schmeck, Ribich, & Ramanaiah, 1977) exchanging lessened validity for the ease of data collection.

Adequate studying behavior certainly is a necessary condition for learning to occur but it is not a sufficient condition. Hence it can only be taken as a mediate or indirect criterion for learning-to-learn.

Motivational and emotional-affective variables. A number of motivational and emotive variables can also be seen as indirect though by no means unimportant variables: Increased learning and achievement motivation, effort-related causal attribution, and self-efficacy normally lead to better learning as well as reduced trait and state anxiety. Measuring problems are involved in the assessment of all of such variables but they can uncover important aspects of the effectiveness of programs determined to improve learning-to-learn. The same is true for the aforementioned questionnaires on studying and working behavior.

Recommendations and conclusion. Our final recommendation can be seen from Table 1. It depicts four types of dependent variables in research into learning-to-learn, two direct and two indirect classes of variables.

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Insert Table 1 about here

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Two conclusions can be drawn from this. 1) There are only a few research projects using these criterion variables. A positive example is given by Dansereau

(1985). 2) Classical behavioristic learning psychology did not use these criteria when studying learning-to-learn (cf. Postman (1969). Instead, they restricted themselves to the learning of material of the same class such that these results only partially pertain to what we mean by learning-to-learn. This may be one reason why only astonishingly few researchers make use of this research.

Prerequisites of Learning

If one intends to improve the students' autonomous learning it is advisable to look for the factors exerting an impact on learning. In this way it is possible to find out those prerequisite factors of learning accessible to teaching. Figure 1 provides with one such prerequisite model of learning (cf. for another one Weinert, 1983).

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Fig. 1 about here

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According to Fig. 1, learning is conceived to be exclusively dependent on studying activities which in turn are dependent on five groups of factors. The figure does not depict the fact that these five groups of factors are not independent of each other but instead interwoven.

The proportion of variance of learning explained by the five groups unfortunately cannot be determined once and for all. In a normal school setting, the largest amount of learning variance is explained by prior knowledge (Gagnè & Paradise, 1961), the other four groups in Figure 1 being, from left to right, of lesser and lesser impact. On the other hand, with unassisted, autonomous learning teacher influence is by definition set at zero, whereas the role of learning strategies may be of increased importance. This also holds for problem solving. Another point deserves to be taken into consideration. Some of the factors can more or less be compensated for by others. In this way, an appropriate teaching

method can, at least to some degree, compensate for insufficient intellectual abilities and even for the lack of prior knowledge (Snow, 1977, 1980), whereas a minimum of motivation and a minimum activation of learning strategies seem to be indispensable in every situation. The conclusion is inevitable that there is no hope to find one group of factors being most important in every setting in order to look for possibilities of improving this group of influential factors. Under these circumstances it seems to be reasonable to briefly assess the possibilities and limits of fostering all of the groups of prerequisite factors.

Prior knowledge. Systematically and broadly enhancing a person's declarative and procedural knowledge is, of course, a central aspect of general education and hence a prominent means of enlarging the range of immediately possible learning. Assisting somebody, however, to learn the art of autonomous or autodidactic learning means enabling the person to educate himself or herself at least partly. Simply helping the learner to accumulate more knowledge does not entail improved learning-to-learn. Such a measure would imply sheer level of achievement as the appropriate criterion variable for learning-to-learn.

By the way, not every piece of knowledge is equally apt to enlarge the range of possible learning: If primarily schemata instead of facts are taught, then the learning of material enriching the pre-established schemata has been supported, i.e. the range of immediately possible learning has been specifically and predictably broadened which would not be the case if mere factual material were learned.

Intellectual capability. Though it is still not unreasonable to question the possibility of training intellectual capabilities at all, recently there have been developed a great number of training programs mostly based upon cognitive psychological foundations (e.g. Sternberg, Ketron, & Powell, 1982, Feuerstein, Rand, & Hoffman, 1982, Klauer, 1988, for comprehensive information see Nickersen, Perkins, & Smith, 1985, Detterman & Sternberg, 1982, Chipman, Segal, & Glaser, 1985, Segal, Chipman, & Glaser, 1985, Schwebel & Maher, 1986). The experiments designed to assess the effectivity of these programs, however,

mostly do not make use of the criterion variables deemed to be adequate for measuring progress in learning-to-learn. Hence, it remains to be shown whether or not these programs are both effective and efficient in promoting the learning of subject matter lying in the range of immediately possible learning, though at least some of them are supposed to enhance learning as well as problem solving capacity.

Environmental factors. In a school setting, the most important environmental factor influencing learning is the teacher with his or her instructional activities. As we are dealing with learning-to-learn, teaching events are to be excluded by definition. On the other hand, there are a great number of influential environmental factors including specially designed learning environments (Tennyson & Rasch, 1988), instructional material the experienced learner should be able to choose according to his or her needs, and finally a host of adverse situational conditions the learner should be able to avoid. There are no serious doubts that all of these environmental factors have a positive or negative impact on learning and this may be the reason why research as well as popular advisory literature for students stress these factors besides motivation and learning strategies, the more so as environmental factors are comparatively easy to manipulate.

Motivation and related factors. Learning motivation is generally deemed to be of great importance for learning to take place but its trainability still might be questioned although there are some promising attempts. Moreover, even the utility of increasing motivation might be disputed since there is no linear relationship between learning motivation and learning. Thus, it is not easy to look for the optimal level of motivation. Emotional and affective factors may also be of importance, particularly the various forms of anxiety (Sieber, O'Neil, & Tobias, 1977). Causal attribution and attitudes such as self-efficacy also play their roles. At least some of these factors are amenable to modification by appropriate treatments. Within certain limits even the student himself or herself may acquire the ability of modificating such factors.

Environmental as well as motivational factors were intensely studied by classical behavioristic learning psychology. There is no prospect of finding a factor in this group that would open up new ways to substantial gains in learning-to-learn.

Learning strategies. The modern information-processing approach of psychology places emphasis on mental operations. Learning strategies are such mental activities and they probably are acquired by learning. Taking this into account, learning strategies are expected to be alterable through certain experiences. On the other hand, they are doubtless one of the activities experts and novices can be discriminated by (Glaser, 1987). Considering all of these aspects, it is obvious that the cognitive psychological approach is highly interested in learning strategies (O'Neil, 1978). Though not undisputed, many cognitive psychological researchers pin their hopes on the teaching of adequate learning strategies for enhancing learning-to-learn as well as problem solving.

Conclusion. Providing students with more knowledge remarkably enlarges the range of possible learning but is a rather tedious affair (Gagné, 1980). Moreover, our criterion requires learning to be assessed independently from prior knowledge. Intellectual capabilities certainly contribute to this learning; it is, however, not yet clear whether the programs of fostering intellectual capabilities have an improving impact on learning new subject matter in the range of immediately possible learning. Situational and motivational factors are well established as influential on learning but they have been stressed by classical learning psychology so that its results -- as far as they are useful for practice -- already have been incorporated in pertinent programs and advisory literature. Hence, many researchers expect new impulses on learning-to-learn to result from the study of learning strategies and the implementation of more efficient learning strategies in the learner's repertoire. Therfore, it seems to be useful to further concentrate research on learning strategies.

Defining learning strategies. Unfortunately, the term is too frequently used and seldom precisely defined. Obviously people are not referring to the same concept if, for example, Chi (1984) supposes that there are only a few learning strategies whereas Hayes (1985) asserts the existence of some hundreds. Similarly, one can question whether all of the authors really are considering the same object when Gick (1986) assumes a great impact of learning strategies on problem solving while others like Siegler (1985) or Glaser (1987) hold that -- besides some rather general techniques -- domain-specific knowledge is, by far, the main determining factor in problem solving. In the same way, the question may be left unresolved whether there is a difference in theory or in semantics if a great number of researchers insist upon the teachability of learning strategies (Aebli, Ruthemann & Straub, 1986, Brown, Campione & Day, 1981, Dansereau, 1985, McKeachie, 1987, Meichenbaum, 1985, Simons & Lodewijks, 1987) while others express serious doubts as far as teachability of learning strategies is concerned (Baron, 1985, Gagnè, 1980, Gagnè & Briggs, 1974, Perkins, 1985) or even suppose negative training effects (Lohman, 1986). To enhance the confusion, other authors prefer the use of different terms in a similar meaning, e.g. terms like heuristics (Kluwe, 1986), tactics (Snowman & McCown, 1984, Derry & Murphy, 1986), chains of operations (Dörner, 1982, Lompscher, 1984), cognitive style (Baron, 1985), metacognition, macro- and metacomponents or executive strategies (Sternberg, 1983), metastrategies (Dansereau, 1985, Pressley, 1986), self-regulation (Fischer & Mandl, 1983), process components (Baron, 1985), or simply activity (Thomas & Rohwer, 1986).

There are, of course, some attempts to define the term (Rigney, 1978, Weinstein & Mayer, 1985). The following definition has some attributes in common with that of Dansereau (1985) and that of Baron (1985): A strategy is a plan of a sequence of actions to attain a pre-established goal. A learning strategy is a plan of a sequence of actions to attain a learning objective. This definition needs several comments.

A strategy is not a simple action but a complex ordered chain of actions. It consists of parts sometimes called tactics (Snowman & McCown, 1984) or, less militarily, techniques. These partial actions are ordered according to the objective or goal that is to be arrived at. If the objective lies outside the person, then one is dealing with strategies for solving tasks or problems. One sort of objective lying within the person is the learning objective. Learning strategies, recall strategies etc. are directed at such an internal objective and hence not so easily recognized by a naive person. This is so much more the case as the degree of awareness of strategies generally can vary (Derry & Murphy, 1986). Young children often do not know about the kind of strategy they use and experts automatically use better strategies than novices right from the first contact with the problem so that even their problem identification is better (De Groot, 1966, Siegler, 1985). In consequence, McKeachie (1987) recommends first to teach strategies consciously in order to automatize their use by practice later on (cf. Salomon & Globerson, 1987). Finally, learning strategies may vary according to their levels of generality: Some strategies may be directed at the learning process as a whole while others may be directed at partial objectives of this process, e.g. at motivation, at informational intake and processing, at recall and retrieval, and so on (Rigney, 1978, Weinstein & Mayer, 1985). That is the reason why a great number (or even too great a number) of strategies can be discerned.

Classification of strategies. There are two main dimensions according to which learning strategies are classified, the subject matter to be learned and the special objective the strategy is to attain. As far as subject matter is concerned a great number of strategies to learn from texts have been developed (Jones, 1983, Fischer & Mandl, 1983, Jones, Amiran, & Katims, 1985, Palincsar & Brown, 1984, Simons & Lodewijks, 1987), others for problem solving (Stanger, 1982, Covington, 1985, Jüngst, 1978, 1987, Green, McClosky, & Caramazza, 1985, Campione & Armbruster, 1985, Herber, 1985, Gick, 1986) or arithmetic tasks (Whimbey & Lochhead, 1981, Resnick & Omanson, 1987, Pressley, 1986). Another example of this type of strategy is given by the variety of mnemonic devices for

the learning of paired-associates (Levin, & DeCancy, 1982).

Referring to the whole of the learning process, strategies can serve different aims, according to which strategies can be classified, too. Dansereau (1978, 1985) developed a complex classification system consisting of two main groups, primary strategies (comprehension, retention, retrieval, utilization) and support strategies (goal setting, mood setting, self-monitoring). Somewhat similar is the system of Weinstein & Mayer (1985) as is that of Thomas & Rohwer (1986), the latter differentiating between cognitive transformational activities (selection, comprehension, memory etc.) and self-management activities (time management, effort management, volitional monitoring).

Considering the purpose of learning strategies one can introduce a third dimension of classification, namely according to the level of generality of applicability, which classification may turn out to be of some importance. On this dimension, strategies vary from highly general to highly specific ones, the most general strategies being directed to maintaining the whole learning process as such. Strategies belonging to this category are those of self-motivating and mood setting, of self-monitoring, of time and effort management, strategies sometimes designated as metacomponents or executive control (Sternberg, 1983) or executive strategies (Gagné, 1985). These strategies are called for with every learning process and they guarantee that the process is started and maintained and that adequate, more special strategies are utilized appropriately, whichever should be needed. These highly general strategies of self-regulating (Fischer & Mandl, 1983) are to be distinguished from macrostrategies, that are characterized by a medium-high generality, i.e. a domain-specific or midrange applicability. These are strategies deserving a limited aim in the learning process because they are directed at performing a certain step like comprehending or memorizing, very often in an even more specific, i.e. subject matter related manner as, for instance, networking (Dansereau, 1978) that can be conceived as a midrange comprehension strategy for the domain of instructional texts. At the lower end of the generality dimension we finally have microstrategies. These are strategies designed for the solving of one individual task as, e.g. the tower of.

Hanoi or a logically equivalent task (Hayes, 1985).

Implications and consequences. As to generality of strategies, program developers are said to prefer the training of most general strategies (Greeno, 1985, Perkins, 1985) because such a training should most probably produce general effects. Bransford, Arbitman-Smith, Stein, & Vye (1985) hold the view that a specific training most likely will entail specific effects whereas Belmont, Butterfield, & Ferretti (1982) reviewed research literature and concluded that only in those cases where very general strategies were trained could general effects be demonstrated. In this way, it seems reasonable to expect generality of effects covarying with generality of trained strategy such that the most general training seems to be the most promising one (Gick, 1986).

On the other hand, however, the most general strategies clearly have the most frequent opportunities to be trained during a learner's life, hence to be overlearned and probably not to be modified by further training (Ferguson, 1956). This may even be true if the person's overlearned general strategies are somewhat unfavourable with respect to his or her learning or problem solving. Attempts to modify such idiosyncratic habits can produce even negative effects, especially if the spontaneously developed strategies are superior to the taught ones (Lohman, 1986). Another point deserves to be mentioned. As to variance explained by prior learning events, it is equally reasonable that solving a specific task or not is much more dependent on the prior learning of a specific piece of knowledge or a specific operation than on the learning of a most general strategy like mood setting, problem identification or time management (Greeno, 1985). If one is to solve a task like that of the tower of Hanoi, it is not so much the mastery of a general strategy but the mastery of a certain trick, a highly specific strategy the solution is dependent on. In this way, both impact on learning and modifiability through training may be inversely proportional to generality or applicability of a strategy. This leads to a differential strategy trade-off according to the level of generality, the most general strategies being of a wide range of applicability but comparatively hard to modify and of relatively small influence with any specific task, and the most

specific strategies conversely being of a very small range of applicability but comparatively easy to modify and for a certain specific task of decisive influence.

Conclusion and recommendation. The optimal trade-off, hence, is expected to be with the training of midrange, domain-specific strategies. They have medium values in all three aspects of generality, modifiability and impact on achievement. They require special programs for a finite number of midrange domains. Examples of such a training are those of reading techniques and learning from instructional texts (Dansereau, 1978, 1985, Brown, Campione, & Day, 1981, Mandl, Stein, & Trabasso, 1984), of problem solving (Jüngst, 1978, 1987), analytical (Whimbey & Lochhead, 1980), or inductive reasoning (Klauer, 1988).

This general recommendation can be slightly differentiated in two ways. Every domain-specific training program calls for the student to learn a great number of objectives and hence opens up a great number of opportunities to learn the most important specific strategies, too. Similarly, every program opens up a host of possibilities to stress more general strategies of learning, and if the different programs are harmonized then there is a greatly increased probability to finally improve even the more general learning strategies. How this might be accomplished is to be shown in following sections.

The Teaching of Learning Strategies

Though one hears important sceptical voices as to the teachability of learning strategies (Gagné & Brigys, 1974, Gagné, 1980, Perkins, 1985), a considerable number of teaching methods have been suggested. Three main groups of such teaching methods can be distinguished, (1) making the learner aware of the strategies used, (2) systematic training, and (3) affective-motivational support of learning and problem solving.

Making the learner aware of strategies. Again three main methods are known to render learners conscious of their use of strategies and of the fact that,

possibly, another strategy could be more effective. Verbalizing someone's own learning or problem solving has been advocated by Kurtz & Hoveland (1953) and used by Ritter & Rotarius (1978) because it is said to improve attending and storage processes or because it is said to foster analytical and systematic scanning as well as conceptual thinking and metacognition (Lochhead, 1985, Whimbey & Lochhead, 1980, 1981), especially if it is done on a tutor-tutee basis, or in a pairwise cooperation (Lochhead, 1985) or in a dialogical procedure (Lipman, 1985). Meichenbaum & Goodman (1971) suggested verbalizing by an expert as model, a method being used by Ritter & Rotarius (1978), as well as by Masendorf & Klauer (1986, 1987). A similar suggestion refers to self-reflecting of the learner's processing, of his or her own operations, their effects and of the changed effects due to modified procedures. There are several German researchers who have made use of self-reflection as a method to teach learning strategies (Dörner, 1982, Dörner, Kreuzig, Reither, & Stäudel, 1983, Putz-Osterloh, 1985, cf. Fischer & Mandl, 1983). Finally, it has been suggested to give learners information about strategies, information about their natures, their pros and cons, and about when to apply which one. This has been advocated by Brown, Campione, & Day (1981), Derry & Murphy (1986), Fischer & Mandl (1983), Meichenbaum (1985), McKeachie (1987), Pressley (1986), in principle by Aebli & Ruthemann (1987) too, although they add that informing students about the advantage of a strategy is only helpful if the strategy's utility is not easy to recognize.

Systematic training. Two kinds of systematic training are in use. The first one consists of training strategies or heuristics after they have been made explicit to the learners. In this case, the application of the strategy in question is practiced. Belmont, Butterfield, & Ferretti (1982) suggest that one general algorithm of problem solving be systematically trained and they conclude that only such a training leads to generally transferable effects. As learning strategies are composed of distinguishable single acts, there arises a problem of how to teach such a composite procedure. Dansereau (1985) suggests (i) a building block teaching approach and (ii) a gestalt approach. The first requires one to teach the component operations successively and separately using specific

materials in order to then teach the whole procedure using samples of the goal material. The gestalt strategy which is finally recommended by the author requires one to first teach the basic structure of the procedure and then to enrich this structure according to the needs of different tasks.

Teaching strategies bears, as already was mentioned above, the danger of negative "mathemathanic" effects (Lohman, 1986, with special reference to Snow, 1977), particularly if the students use a strategy superior to the taught one. Actually, Dansereau (1985) found in one experiment the control group to outperform the specially trained group (see also for more detailed results Sternberg, Ketron, & Powell, 1982). Thus, training of strategies is a somewhat critical affair that should not be put in use schematically.

The second kind of method of systematically training strategies is by providing the students with a series of tasks arranged in such a way that working through the series suggests the application if not even the acquisition of a certain strategy. In this case, the strategy can be previously taught explicitly or not. If not, the students are given the opportunity to find out that strategy that is most suitable to themselves as well as to the series of tasks. Very often this kind of practice training is combined with a deliberate training for transfer in that a great variety of tasks is offered whereby ecological validity of the training program is increased (Derry & Murphy, 1986, Feuerstein, Rand, & Hoffman, 1982, Klauer, 1987 a, b, c, McKeachie, 1987, Meichenbaum, 1985). Another reason for such a practice training is given by the need of automatization (Salomon & Globerson, 1987) since experts obviously have automatized a great many procedures that novices need to perform in a highly controlled way (De Groot, 1966, Neber, 1987, Siegler, 1985).

Affective-emotional and motivational support. Different researchers and program authors stress the importance of affective and motivational support. Dansereau (1985), as was mentioned above, deals explicitly with mood setting and mood maintenance as support strategies whereas reduction of fear of failure, test and achievement anxiety is a well-established method of enhancing learning

strategies and achievement (Richardson, 1978, Sarason, 1987). Positive attitudes against achievement are generally effective and help students to recognize commonalities (Isen, Daubman, & Gorgoglione, 1987, Neber, 1981). Humor and humorous material often entails better achievement (Malone & Lepper, 1987, Ziv, 1983) though there is evidence of negative effects, too (Baker, Herman, & Yeh, 1981). Finally, establishing a sense of self-efficacy and effort-related causal attribution has been strongly advocated by different authors as, e.g. Meichenbaum (1985).

Some research has been done to demonstrate that the combination of training methods with affective supporting methods is especially useful. Allen (1972) was able to show that combining counseling and training of study techniques with a behavioristic anxiety reduction treatment led to improved academic performance.

Conclusion and recommendations. As far as instructional research is concerned it is a sound strategy to successively decompose a complex set of influential factors in order to evaluate the effectiveness of every single factor and to later recombine the single factors one after the other and to evaluate possible interaction effects between them. Although not all of this research has been performed by now, some preliminary conclusions and recommendations are justified.

A learning strategy refers to a plan or an ordered set of mental activities designed for a certain purpose. Contrary to "normal" circumstances both the purpose and the activities of the strategy do not lie outside but within the person, i.e. they are mental events. That is the reason why the teaching of a learning strategy is different from teaching of most of the regular instructional objectives. Given that the research available is not quite misleading and that a cautious extrapolation remains valid, the teaching of such a metacognitive instructional objective might be pursued along the following lines of a three-step procedure being embedded in a certain emotionally and affectively supportive environment.

The first step is rendering the learners aware of their learning strategies by the different techniques of verbalizing and self-reflecting. The main purpose of this step is to direct the learner's attention to his or her own way of dealing with the learning objective instead of being fixed at the learning objective alone. The learner is to realize that there are learning strategies, that he or she also uses one of them, that his or her strategy is possibly not the optimal one. One additional way of doing so has been proposed by Case (1980). He recommends demonstrating especially to young children that their own strategies probably lead to failure and that it is useful to change one's strategy and adopt another one.

The next step consists of informing the learner about learning strategies, about the nature of the available strategies, their advantages and disadvantages and about when to use which one. Caution seems to be advisable when informing students about learning strategies and especially when teaching a new strategy in order not to confuse them: Looking at their own learning activities is not what students are used to when learning something. Particularly, the teaching of a new strategy is only appropriate if the teacher is sufficiently sure that the student uses an inferior strategy. In this case it seems to be advisable to use Dansereau's gestalt technique.

The last step requires the teacher to provide the students with a great number of adequately sequenced practice using tasks from all relevant fields. The aim of this phase is two-fold: Teaching for transfer of the strategy into all relevant areas of application whereby the ecological validity of the teaching program is guaranteed as well as the automatizing of the strategy in question so that the students will be able to perform it without inappropriate volitional effort and control.

All this needs to be done in an appropriately released and positive atmosphere already leading to some anxiety reduction which has to be followed by special interventions if necessary. A further important aspect is, however, to inform the learners about the indispensable influence of learning motivation and

attention and to teach them how to get it, at least partly, under their own control.

The Curriculum

An important question still has been left open, that of the curriculum. The first point to be clarified is whether or not special curricula for learning-to-learn are to be developed. As a matter of fact, however, it is to be recognized that several such curricula already have been designed, e.g. by Dansereau (1978, 1985), McKeachie (1987), or Weinstein & Underwood (1985). Others have been constructed for implementing analytic thinking (Lochhead, 1985), problem solving (Jüngst, 1978) or even general intelligence (see the comprehensive volumes edited by Chipman, Segal, & Glaser, 1985, Detterman & Sternberg, 1982, Nickerson, Perkins, & Smith, 1985, Schwebel & Maher, 1986, or Segal, Chipman, & Glaser, 1985). Thus, the only thing to be clarified is whether or not such curricula can be justified or whether there are alternative solutions to be taken into consideration.

One aspect of the issue has already been dealt with, i.e. the question of training very general as opposed to domain-specific strategies. The question has been decided in favor of the latter: Considering the differential trade-offs, it seems to be advisable not to plan one general strategy training but instead different domain-specific training procedures, even if they are to be unified by directing the learner's attention to the more general strategies at a later phase. Another aspect of the issue has not yet been dealt with, namely the question of a detached or embedded curriculum (Derry & Murhphy, 1986). A detached curriculum provides for an isolated instruction, for a sort of separate subject "learning-to-learn" like mathematics or music. An embedded curriculum provides for instructing the students about learning-to-learn within the different subjects. Thus, domain-specific training of learning strategies can appropriately be accomplished using an embedded curriculum whereas a detached curriculum might be advisable for special cases, for instance slow learners or

gifted students or for children in need of special assistance for some other reasons.

The embedded curriculum has, of course, a better chance of being incorporated into the normal school curriculum but it requires teachers with a suitable qualification and readiness. The teacher must not only be a specialist in the subject matter and in teaching this subject matter, he or she also must know the method of teaching the methods how to learn in this area of subject matter as Gaudig (1917) has put it. This conception implies that the teacher should be taught not only about the teaching methods appropriate to the subject matter in question but also about the appropriate learning methods and about the teaching of these methods. Domain-specific curricula for learning-to-learn may turn out to be helpful as far this aspect of teacher education is concerned, for instance the program developed by Jones, Amiran, & Katims (1985) designed for learning-to-learn in the area of language skills.

If students are, right from the beginning, instructed not only about the subject but also about how to learn it, then they will, in the long run, acquire a considerable number of specific learning techniques. Equipping the students with a reservoir of subject-related efficient learning techniques is a main step in enabling them to acquire independently new knowledge. It is, however, not yet sufficient. In order to render the students capable of <u>autodidactic</u> learning they must learn to control the learning process as a whole, to self-regulate it. The phase of autodidactic learning requires the student to be, in a sense, his or her own teacher, i.e. doing what a good teacher would do in guaranteeing an effective learning process. To put it another way, the student must take upon himself or herself the responsibility that all of the teaching functions be set in action. Teaching functions are those effects that are to be realized within a learner so that the desired learning will take place (Klauer, 1985). Based upon an information-processing approach, I derived six molar teaching functions: Motivation, information, information processing, storing and retrieving, transfer, controlling and directing.

The last one, controlling and directing, is normally executed by an adequately planned instruction, and with autodidactic learning the learner is to appropriately plan his or her own learning. Thus he or she needs information about the five other teaching functions and how to realize them. In fact, if an embedded domain-specific curriculum of learning-to-learn has been adopted, then the learner already knows how to motivate himself or herself, how to provide himself or herself with information, how to process and how to store it so that it can always be retrieved and transferred, and that in mathematics, English, and so on. He or she is now in need of binding all of it together, to learn that all of these teaching functions are to be realized in a certain sequence. The learner is only then a real autodidactic learner if he or she masters this task of self-managing the own learning process in an enlightened, sensitive manner guaranteeing that all of the teaching functions are appropriately taken into consideration, that for instance no new subject is to be learned when the preceding one has not yet been practiced accordingly. Thus, the learner must be both able and ready to test the own level of accomplishment, making the further progress dependent on the results, that is to take over the responsibility for his or her own learning.

Conclusion and recommendations. A detached special learning-to-learn curriculum can generally not be recommended though it may be useful for certain cases of above-average or below-average learners. Instead of this, it seems advisable to develop embedded domain-specific curricula of how to learn within the various subjects and to qualify the teachers to teach these techniques, too.

On the other hand it is deemed necessary to instruct the students how to regulate and control their own learning processes enabling them this way to reach the level of autodidactic learning. This requires the students to be informed about some basics of teaching and learning, about some general aspects of managing one's own learning. As a result, a combination of domain-specific and general training of learning-to-learn seems to be advisable. Derry & Murphy (1986) arrived at the same conclusion whereas they, however, advised to start with a general instruction about learning-to-learn using a detached curriculum

and to modify this general information later on in a domain-specific way and within each subject. After all, this sequence cannot be recommended. It seems possible to sensibly teach first graders how to learn specific tasks such as, for instance, paired-associates using the key word-method but it does not make sense to teach them about the general aspects of autodidactic learning. Such an information should be postponed to a more mature age.

Discussion and Concluding Remarks

To come full circle to our concern about enhancing learning ability, the prerequisite factors of learning as depicted in Figure 1 should be taken into consideration again. Of the factors prior knowledge, intellectual capability, environmental factors, emotional and motivational factors, and learning strategies the last three have been dealt with in a more or less degree. As a result a differentiated system of interventions has been proposed the most of them being able to be integrated in the normal school curricula for the various subjects. This holds for all of the domain-specific learning techniques that should be taught in combination with the respective subject matter so that both, the acquisition of subject knowledge as well as the techniques of learning them, could be enhanced. There are only some very general techniques of learning comprising all of the others and being applicable to the learning of every kind of subject matter, therefore better to be learned in a relatively late phase of human development and education. This refers to the level of autodidactic learning where the learner should be put in a position to take over the responsibility for his or her own independent learning by taking over the realization of the teaching functions for himself or herself.

It is clear that such a program does not represent more than a -- possibly -- realistic hope for the future since it implies there is still much research and development to be performed. On the other hand, however, much has been done already so that the program may not be more than a thorough extrapolation of current trends toward an attainable end.

It seems possible that two other developments will contribute to the aim of enhancing learning. As has been mentioned, prior knowledge and intellectual capabilities were, for different reasons, not to be included in this article on learning-to-learn but developments in these areas of research also can contribute to the end of enhanced learning. Referring to the teaching of knowledge, to switch over from the teaching of factual material to the teaching of schemata of knowledge possibly implies less teaching without necessarily less learning, exactly what Comenius wanted to arrive at when he wrote his Didactica Magna. Such a result only seems possible as a combination of enhanced learning ability with a kind of knowledge acquisition that facilitates the independent acquisition of factual knowledge to be integrated into previously acquired schemata.

The second development that may open up new ways of teaching for learning-to-learn is taking place in the field of training intellectual capabilites. As has been mentioned earlier there are several promising approaches as, for instance, those of Feuerstein (Feuerstein et.al., 1986) or Sternberg (1983) or the author's paradigmatic conception (Klauer, 1988). It is, of course, too early to finally evaluate the prospects of this research but it is remarkable how many researchers in different countries of the world are just now joining in attempts, based upon cognitive theories, of fostering intellectual functioning.

As has been pointed out it is only during the last few years and a result of the cognitivistic turn that research has addressed learning-to-learn in a proper sense. That which classical behavioristic psychology of learning did put under this heading was restricted to learning of material of a certain class such as, for instance, paired-associates. It is only during these years that large-scale research and development has been performed in order to clarify the question of how to improve the quality of learning, of how to render students capable of being more efficient and independent or even autodidactic learners.

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Table 1: Criterion Variables for Learning-to-Learn

Primary, direct criterion variables

1) Learning of any subject matter in the range of immediately possible learning
(Short term criterion requiring experimental designs)

2) Learning of a more complex subject matter
(Medium or long term criterion requiring quasi-experimentation)

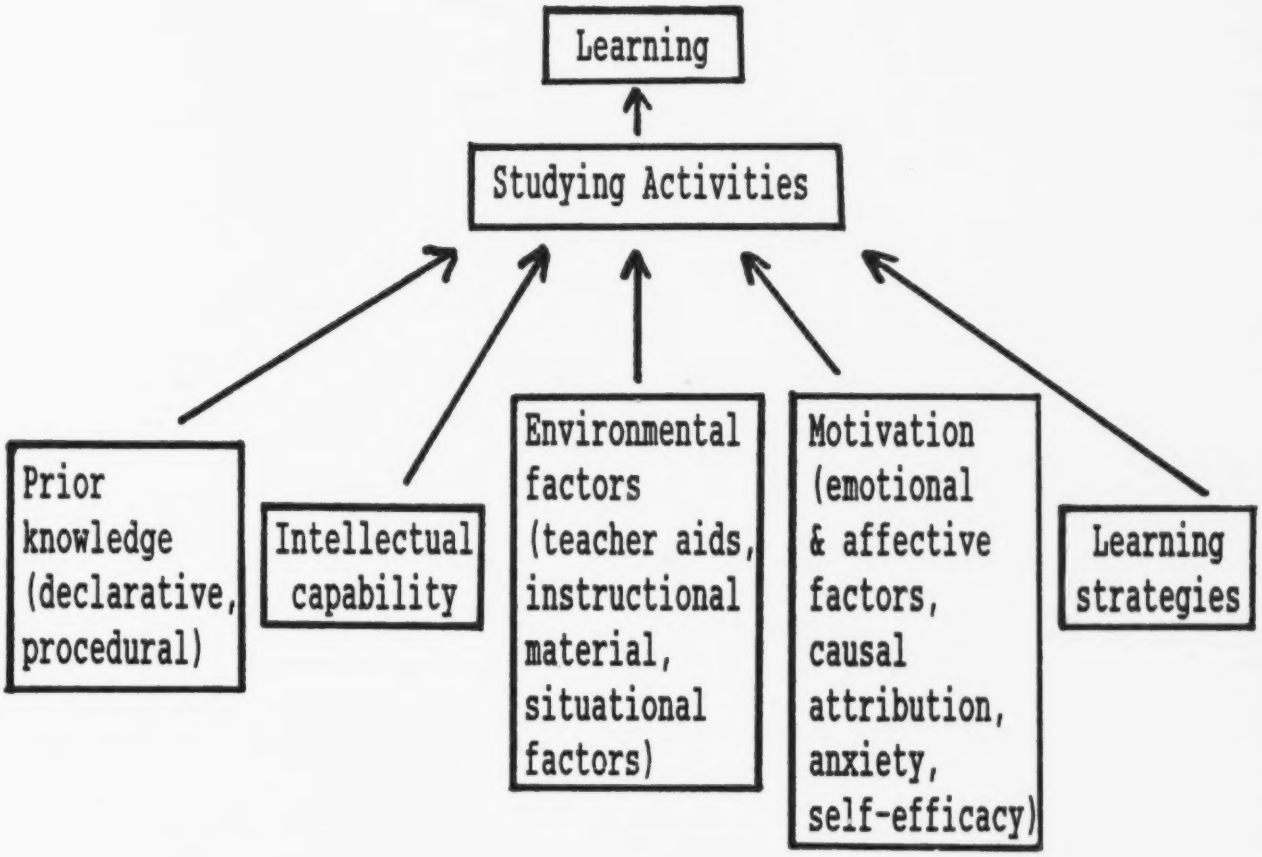
Secondary, indirect variables

3) Studying behavior
(Direct observation or questionnaires)

4) Motivational, emotional & attitudinal variables
(Mostly via questionnaires)

Figures Captions

Figures 1. Prerequisites of learning


Learning
Studying Activities
Prior knowledge (declarative, procedural)
Intellectual capability
Environmental factors (teacher aids, instructional material, situational factors)
Motivation (emotional & affective factors, causal attribution, anxiety, self-efficacy)
Learning strategies